Slide 1	Malignant Catarrhal Fever *Malignant Catarrh,* *Malignant Head Catarrh,* *Gangrenous Coryza,* *Catarrhal Fever, Snotsiekte*	Malignant catarrhal fever is an infectious disease of ruminants. It is also referred to as malignant catarrh, malignant head catarrh, gangrenous coryza, catarrhal fever, and snotsiekte, which is a South African word meaning "snotting sickness".
Slide 2	**Overview** • Organism • Economic Impact • Epidemiology • Transmission • Clinical Signs • Diagnosis and Treatment • Prevention and Control • Actions to take  Center for Food Security and Public Health Iowa State University - 2004	In today's presentation we will cover information regarding the organism that causes Malignant Catarrhal Fever and its epidemiology. We will also talk about the economic impact the disease has had in the past and could have in the future. Additionally, we will talk about how it is transmitted, the species it affects (including humans, if applicable), clinical and necropsy signs seen, and diagnosis and treatment of the disease. Finally, we will address prevention and control measures for the disease as well as actions to take if Malignant Catarrhal Fever is suspected. Photo: hartebeest.
Slide 3	The Organism	
Slide 4	**The Organism** • Gamma herpesvirus • Serotype species and geographically dependent – AHV-1 natural host: wildebeest in Africa – OHV-2 natural host: domestic sheep worldwide – AHV-2 nonpathogenic – CpHV-2 natural host: goats Center for Food Security and Public Health Iowa State University - 2004	Malignant catarrhal fever is caused by one of two gamma herpesviruses. The specific serotype varies depending on species and geographic distribution. Wildebeest in Africa are the natural host species that carry the alcelaphine herpesvirus-1 (AHV-1). All varieties of domestic sheep in North America and throughout the world are carriers of ovine herpesvirus-2 (OHV-2). MCF in these natural hosts do not experience clinical disease. Alcelaphine herpesvirus-2 (AHV-2) is non-pathogenic but is latently carried by wildebeest, hartebeest, and topi. Most recently it was discovered that worldwide, goats are endemically infected with caprine herpesvirus-2 (CpHV-2) and it apparently only causes disease in deer.
Slide 5	Importance	

Slide 6

History

- MCF in wildebeests in Africa for centuries
- U.S. cattle since 1920's
- First bison case in South Dakota in 1973
- Cases occur worldwide each year
- 2002: New Jersey exotic theme park
  - AHV-1 diagnosed in Ankoli cattle

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Malignant catarrhal fever that is associated with wildebeests has been recognized in Africa for centuries. Reports of a disease resembling MCF has been present in cattle in the United States since the 1920's. South Dakota reported the first bison case of MCF in 1973. Cases are reported worldwide in many different species. Most recent U.S. infection occurred in October 2002 in an exotic wildlife theme park in New Jersey. AHV-1 was diagnosed using PCR in three Ankoli cattle out of a herd of 31 and originated from the fetal fluids of a wildebeest.

Slide 7

Economic Impact

- Variable given the carrier status
- Zoologic parks affected through losses of expensive animals
- Not reportable in all 50 states
  - Tracking true losses difficult
- Concern for bison breeders, cattle producers, elk and deer farmers

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Given the carrier status of this virus in the sheep, goat and wildebeest population, economic impact could be variable. There are multiple species susceptible to infection as you will see in the coming slides, and many different industries could be affected. Zoologic parks spend hundreds to thousands of dollars on some of their exotic species and could later lose them to infection with MCF. As this is not a reportable disease in all 50 states, tracking the true economic impact is difficult. It is a concern for bison breeders, as well as cattle producers, elk and deer farmers, but hard numbers were hard to find to quantify their potential losses from this fatal disease.

Slide 8

Epidemiology

Malignant catarrhal fever caused by AHV-1 is carried by wildebeest, hartebeests, and topi and found in the wild primarily in Africa. Wildebeest in zoological and wild animal parks are also asymptomatic carriers. The disease caused by OHV-2 is seen throughout the world as all domestic and wild sheep appear to have antibodies to this virus. Goats are also carriers of OHV-2. Top photo: wildebeest, bottom photo: topi antelope.

Slide 9

Geographic Distribution

- AHV-1 primarily in Africa
  - Carried by wildebeest, hartebeest, topi
  - Also in zoologic and wild animal parks
- OHV-2 worldwide
  - Carried by domestic and wild sheep and goats

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Slide 10

Geographic Distribution

- Positive bison have been found in U.S. and Canada
  - Utah, Wyoming, Colorado, Montana, California, Oregon, Ohio, Kansas, Nebraska, North Dakota, South Dakota
  - Saskatchewan, Ontario, and Alberta
- Often misdiagnosed in bison

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As of February 2000, there were 11 states in the U.S and 3 Canadian provinces that had OHV-2 positive bison or bison herds. They include Utah, Wyoming, Colorado, Montana, California, Oregon, Ohio, Kansas, Nebraska, North Dakota, South Dakota and in Canada, Saskatchewan, Ontario, and Alberta. Often the disease gets misdiagnosed but veterinarians need to be aware of this disease. Data is not as readily available for cattle or elk herds to know if disease is enzootic in these species.

Slide 11

Morbidity/Mortality

- Carrier species asymptomatic
  - Wildebeest, hartebeest, topi, sheep, goats
- Low morbidity in other species
  - U.S. outbreaks 30-40% recently
- Mortality 100% in:
  - Cattle, white-tailed, axis, Pere David's deer
- Mortality 1% in:
  - Water buffalo, farmed deer, fallow deer

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Carrier species (wildebeest, hartebeest, topi, sheep, and goats) are asymptomatic and morbidity involving other species is generally low. In the last 30 years, U.S. outbreaks have had morbidity ranging from 30-40% and are usually associated with the source animal remaining on the premises. Mortality rates can reach 100% in animals with clinical signs, namely domestic cattle, with highest incidence in those between 6 months and 4 years of age. White-tailed, axis, and Pere David's deer also have extremely high mortality rates. Water buffalo, farmed deer, and fallow deer have much lower mortality rates, around 1%. Top photo: Pere David's Deer; bottom photo: Axis deer.

Slide 12

Transmission

Animal transmission varies depending on the serotype and species. AHV-1 is cell-associated in adult carriers and is rarely transmitted to other animals. Stressing the animals will cause shedding of the cell-free virus in nasal secretions making spread to other susceptible animals (namely cattle) via aerosol possible. Cell-free virus can also contaminate feed and water and be spread through arthropods. Neonatal wildebeest from 4 days to 4 months of age can shed cell-free virus in their lacrimal and nasal secretions and feces.

Slide 13

Animal Transmission

- AHV-1 cell associated
  - Rarely transmitted
  - Stress induces shedding cell-free virus
    - Nasal secretions via aerosol
    - Contaminate feed, water
    - Arthropods
  - Neonatal wildebeests 4 days to 4 months
    - Shed in lacrimal, nasal secretions, feces

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Cattle-to-cattle, bison-to-bison, or deer-to-deer transmission is rare and they considered are dead end hosts once infected with OHV-2 or AHV-1. OHV-2 transmission is not completely understood. It has never been isolated as an intact virion, so all theories are experimental results. All ages of sheep can be infectious to susceptible animals but spread to cattle most often occurs during lambing, although nasal secretions are often to blame. Lambs become infected after birth up to 4 months of age. Placental transmission is possible, though rare. Goat spread of OHV-2 is unknown. Photo of a sheep and her 3 lambs.

Slide 14

Animal Transmission

- Same species horizontal transmission is rare
  - Dead end hosts
- OHV-2 transmission not understood
  - All ages of sheep infectious
  - Spread to cattle during lambing
  - Lambs infected by 4 months
  - Goat spread unknown

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MCF has not been documented to cause disease in humans. As the exact transmission of OHV-2 remains unknown, persons assisting in lambing should take precautions not to contaminate cattle areas. This virus is quickly inactivated by sunlight, which helps decrease the chance of fomite spread.

Slide 15

Human Transmission

- MCF has not been documented as causing disease in humans
- Caution at lambing time
  - Equipment used could spread infection to susceptible animals
- Virus quickly inactivated by sunlight
  - Minimizes risk of fomite spread

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Slide 16

Animals and Malignant Catarrhal Fever

Slide 17

Species Affected

- Carrier species
  - Sheep, goats, wildebeest, hartebeest, topi
- Susceptible species
  - Cattle, bison, elk, reindeer, moose, domestic pigs, giraffe, antelope, wapiti, red and white-tailed deer, Pere David's deer, white-tailed & white-bearded gnu, gaur, greater kudo, Formosan sika deer, axis deer, nilgai, banteng

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As discussed previously, sheep, goats, wildebeest, hartebeest, and topi are carriers of MCF but are asymptomatic. Other species, including cattle, bison, elk, reindeer, moose, domestic pigs, giraffe, antelope, wapiti, red deer, Pere David's deer, white-tailed deer, white-tailed gnu, white-bearded gnu, gaur, greater kudo, Formosan sika deer, axis deer, nilgai, and banteng are susceptible to MCF and can develop an infection. Water buffalo and farmed deer can also be affected but with much less mortality.

Slide 18

Clinical Signs

- Incubation period 9 - 77 days experimentally
  - Unknown in natural infections
  - Subclinical infections develop under stress
- Initial clinical signs
  - Depression, diarrhea, DIC, dyspnea, high fever, inappetence
  - Sudden death

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Experimental infections have an incubation period of 9 to 77 days but it is unknown in natural infections. Some animals are subclinically infected and develop disease when they become stressed. Clinical signs initially include depression, diarrhea, disseminated intravascular coagulation (DIC), dyspnea, high fever of 105.8^{o}F to 106.7^{o}F, inappetence, and often, sudden death.

Slide 19

Clinical Signs

- Acute form: Sudden death
- Head and eye form
  - Majority of cattle cases, progress through stages
- Intestinal form
  - Initial head and eye but die of severe diarrhea
- Mild form
  - Inoculated animals; recover

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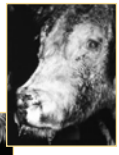
Cattle have four clinical forms that MCF can take. First is the acute form where sudden death can occur, which is common among deer. Second is the head and eye form which is the most common in cattle. It progresses through the early signs of fever, reddened mucosa and enlarged prescapular lymph node. Eventually the lesions become necrotic and death can occur. Third is the intestinal form which has the same early signs as the head and eye form but the animal dies of severe diarrhea before the lesions become necrotic. The fourth form is mild and only occurred in cattle that were experimentally inoculated with an attenuated virus and recovered. Deer and antelope may have minimal lesions or be less specific than cattle or bison, but many of the same signs occur.

Slide 20

Head and Eye Form- Early stages

- Reddened eyelids
- Bilateral corneal opacity
- Crusty muzzle, nares
- Nasal discharge
- Salivation



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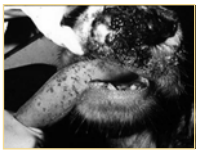
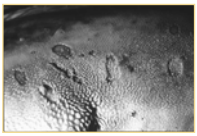
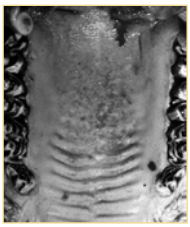
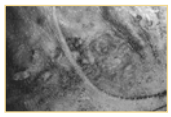
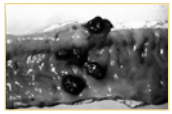
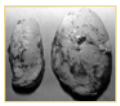
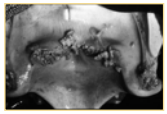
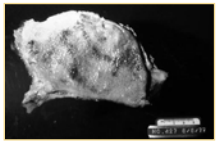
In the early stages of the head and eye form this disease can cause conjunctivitis, reddened eyelids, and bilateral corneal opacity, as well as serous or thick nasal discharge, crusty muzzles and nares, open-mouthed breathing, and salivation in bovidae species (cattle, bison). Photos taken from APHIS USDA FAD training module at www.aphis.usda.gov.

Slide 21	**Head and Eye Form- Later stages**  • Erosions on the tongue  • Erosions on the buccal mucosa Center for Food Security and Public Health Iowa State University - 2004	Cattle and bison may have areas of erosions on the buccal mucosa and necrosis and hyperemia in the oral cavity in the later stages of the head and eye form. The skin can ulcerate and hardened scabs form on perineum, udder and teats. Photos taken from USDA APHIS FAD training module at http://www.aphis.usda.gov
Slide 22	**Clinical Signs in Bovidae** • Joints, superficial lymph nodes swell • Horn, hoof coverings slough • Nervous signs – Incoordination, head pressing, nystagmus, hyperesthesia  Swollen pre-scapular lymph node Center for Food Security and Public Health Iowa State University - 2004	Joints and superficial lymph nodes may swell and the horn and hoof coverings may slough in some animals. Finally, some animals exhibit nervous signs such as incoordination, head pressing, nystagmus, and hyperesthesia. Photo depicts a swollen prescapular lymph node on a cow and taken from APHIS USDA FAD training module at www.aphis.usda.gov
Slide 23	**Post Mortem Lesions** • Erosions on the tongue and soft and hard palate   Center for Food Security and Public Health Iowa State University - 2004	As the clinical signs depict, this multisystemic disease can cause post mortem lesions in the gastrointestinal, respiratory, and urinary tracts. The actual severity depends on the course of the illness. The gastrointestinal tract can be affected starting in the oral cavity as pictured with the erosions on the tongue and the hard and soft palate of a cow. Taken from APHIS USDA FAD training module at http://www.aphis.usda.gov
Slide 24	**Post Mortem Lesions** • Necrotic areas in the omasal epithelium  • Multiple erosions of intestinal epithelium  Center for Food Security and Public Health Iowa State University - 2004	With sudden death, hemorrhagic enterocolitis in the infected animal may be the only sign. Erosions and necrotic areas appear throughout the omasum and intestinal tract. Taken from APHIS USDA FAD training module at http://aphis.usda.gov
Slide 25	**Post Mortem Lesions** • Greatly enlarged lymph node compared to normal  • Necrotic areas in the larynx – Diptheritic membrane often present  Center for Food Security and Public Health Iowa State University - 2004	As noted in clinical signs, the lymph nodes can be greatly enlarged with MCF. The prescapular lymph node is much larger compared to the normal node beside it. Other cases may exhibit catarrhal accumulations, erosions and a diptheritic membrane in the respiratory tract. Note the necrotic areas on the larynx in the bottom photo which is sometimes accompanied by a diptheritic membrane. Photos taken from APHIS USDA FAD training module at http://www.aphis.usda.gov

Slide 26

Post Mortem Lesions

- Urinary bladder mucosa hyperemic and edematous
- Kidney often has raised white foci on the cortex



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The urinary bladder may have hemorrhagic, edematous areas and raised white foci on the renal cortex. The mucosa of this bladder is hyperemic and edematous due to MCF infection. Photo taken from APHIS USDA FAD training module at http://www.aphis.usda.gov

Slide 27

Differential Diagnosis

- BVD mucosal disease
- Bluetongue
- Rinderpest
- FMD
- Vesicular stomatitis
- Salmonellosis
- Pneumonia complex
- Oral exposure to caustic materials
- Mycotoxins
- Poisonous plants

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Due to the similarity of lesions, differential diagnosis consist of bovine viral diarrhea mucosal disease, bluetongue, rinderpest, foot and mouth disease, vesicular stomatitis, salmonellosis, pneumonia complex, oral exposure to caustic materials, mycotoxins, and some poisonous plants.

Slide 28

Sampling

- Before collecting or sending any samples, the proper authorities should be contacted
- Samples should only be sent under secure conditions and to authorized laboratories to prevent the spread of the disease

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Before collecting or sending any samples from animals with a suspected foreign animal disease, the proper authorities should be contacted. Samples should only be sent under secure conditions and to authorized laboratories to prevent the spread of the disease.

Slide 29

Clinical Diagnosis

- Any susceptible animal with sudden death, fever, erosions of the mucosa, nasal/lacrimal discharge, bilateral corneal opacity should be tested for MCF
  - Particularly with a history of exposure to sheep, goats, antelope, or wildebeest during parturition

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Based on the clinical signs described, MCF should be suspected in susceptible animals if they have been exposed to sheep, goats, antelope or wildebeest, particularly around parturition. Animals that suddenly die or have a fever and erosions of the mucosa, nasal and lacrimal discharge, and bilateral corneal opacity should be tested for MCF.

Slide 30

Diagnosis

- Laboratory Tests
  - Histopathology, PCR
    - Quantify with PCR, not specify
  - Virus isolation for AHV-1
  - Serology
    - AHV-1 antibodies in wildebeest
      - Immunofluorescence in ruminants
    - OHV-2 antibodies in sheep, cattle using IF
      - CI-ELISA for screening

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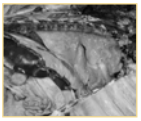
To diagnose MCF, histopathology of the lymphoid tissue can be done, but PCR tests are becoming the standard to detect AHV-1 and OHV-2 viral DNA. Scientists have developed a PCR that will quantify the amount of MCF virus present, but cannot specifically identify which of the herpesviruses it is. Virus isolation can be done for AHV-1 but has not been successful for OHV-2. Serology to detect antibodies has been successful for identifying AHV-1 in wildebeest. In clinical cases of ruminants, immunofluorescence (IF) and immunoblotting should be used. OHV-2 antibodies can be detected with IF in sheep and cattle. As a screening tool, a competitive inhibition enzyme linked immunosorbent assay (CI-ELISA) was developed for use on susceptible animals as well as carrier species.

Slide 31	**Sample Collection** • Blood in EDTA tube for virus isolation • Fresh tissue collected and refrigerated immediately after death – Spleen, lung, lymph nodes, adrenal glands • PCR on peripheral blood, fresh tissues • Paired serum samples  Center for Food Security and Public Health Iowa State University - 2004	In order to isolate the virus, 10-20 mls of blood should be collected and put in an EDTA tube. The virus is quickly inactivated in dead animals so spleen, lung, lymph nodes, and adrenal glands should be collected as soon as possible and refrigerated (NOT frozen) and sent for virus isolation, fluorescent antibody, or immunoperoxidase tests. In order to run a PCR test, peripheral blood, fresh tissues or paraffin-embedded tissue samples must be used. As some animals have antibodies to the virus, paired sera should be used to identify an infection.
Slide 32	**Treatment** • Survival is rare • Mortality reaches 100% • Supportive therapy, antibiotics for secondary bacterial infection – Recovered animals will remain virus carriers Center for Food Security and Public Health Iowa State University - 2004	Mortality in clinically ill animals is nearly 100% and survival in other exposed animals is rare. Supportive therapy (fluids) and antibiotics for secondary bacterial infections can be tried for valuable animals. If they recover they will remain virus carriers and could spread infection.
Slide 33	MCF in Humans	MCF has never been documented to cause infection in humans.
Slide 34	Prevention and Control	
Slide 35	**Recommended Actions** • Notification of Authorities – Federal: Area Veterinarian in Charge (AVIC) www.aphis.usda.gov/vs/area_offices.htm – State veterinarian www.aphis.usda.gov/vs/sregs/official.htm • Quarantine • Disinfection – Susceptible to common disinfectants – Sunlight will destroy the virus Center for Food Security and Public Health Iowa State University - 2004	The state veterinarian should be informed of any suspected case of malignant catarrhal fever as it is a reportable disease in many states. They will decide the next course of action. Should an outbreak occur, clinical and carrier animals should be immediately separated from susceptible species in order to contain the disease. These herpesviruses, AHV-1 and OHV-2, are highly susceptible to commonly used disinfectants, and sunlight will kill them as well.

Slide 36

Prevention and Control

- Separate infected and carrier animals from susceptible species
  - Sheep and goats are carriers
- Avoid exposing cattle, bison, deer during parturition

- Zoological parks:
  - Introduce seronegative animals only
- No vaccine available

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Should an epidemic occur, clinical and carrier animals should be separated from susceptible species. As domestic sheep and goats are asymptomatic carriers, they should be kept separated from cattle at all costs, especially during parturition. African wildlife, wildebeests, hartebeests, and topi, should also be kept separated from cattle to limit the spread of infection. Zoological parks should only introduce seronegative animals and follow strict quarantine restrictions of newly acquired animals. There is no vaccine currently available, but experimental evidence in cattle has shown some protection from challenge inoculation.

Slide 37

Additional Resources

Slide 38

Internet Resources

- USDA Training Manual- MCF
  aphisweb.aphis.usda.gov/vs/ep/fad_training/Malivol5/mal5index.htm
- World Organization for Animal Health (OIE) website
  - www.oie.int
- USAHA Foreign Animal Diseases – "The Gray Book"
  - www.vet.uga.edu/vpp/gray_book/index

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Slide 39

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Slide 40

Acknowledgments

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